THE CURRENT METER OF PROFESSOR A. R. HARLACHER.*

Every one who has had occasion to measure the velocity of water in rivers or tidal currents has complained, and with reason, that the instruments in use for that purpose are inconvenient, and do not give results scientifically satisfactory. With Woltman's current meter, which has been chiefly used, the operation of determining the velocity is delayed and rendered laborious by the necessity of removing the meter from the water for every reading of the number of rotations. Nevertheless, this instrument is the only one which can be used in large and deep rivers. One cause of the inaccuracy of the results obtained by this instrument is that considerable time is required to determine the velocity at different depths in any vertical section, and a still longer time to repeat the operation at a sufficient number of verticals to give a good value of the mean velocity at the cross section. In most cases the level of the water-surface varies during the operations, and thus the different velocities are not ascertained under the same conditions, and cannot agree accurately with each other. Some engineers, therefore, have tried to shorten the time required for such measurements, by improving the method of counting the rotations of the meter. Thus Mr. Ritter (Engineer-in-Chief Ponts et Chaussées), at Paris, in 1859, and Mr. Henry, when measuring rivers flowing into Lake Erie, in 1867, adopted a method for electrically registering the number of rotations of the meter, and dispensing with the necessity for lifting it out of the water for each reading. Mr. Ritter, especially, took great pains to improve the current meter in this way, but arrived at no satisfactory results. Professor Harlacher, of the Technical High School at Prague, was the first to construct a current meter which obviates all the difficulties and drawbacks of the instruments previously employed. The Harlacher current meter permits the velocity to be determined in the shortest possible time. Before describing the details of the instrument a general statement may be given of its merits and advantages.

The current meter is a screw meter on the same general principle as the old instrument of Woltmann. Connected with it is an indicator, or clock, actuated electrically, which shows the number of rotations of the screw. The meter is suspended in the water by a cord so that it can be raised or lowered at will. It can therefore be readily placed at any depth or allowed to descend slowly and uniformly from the surface of the water to the bed of the river. The instrument is never taken out of the water until the measurements in one vertical of the section are completed, because the electric registration of the rotations is affected above water. When the mean velocity at one vertical is required, that is most easily obtained by allowing the meter to descend regularly and slowly along that vertical from the surface of the river. The number of rotations on the electric indicator and the time are noted. Dividing the rotations by the time, the mean rate of rotation of the meter, corresponding to the mean velocity of the stream, is found. The result is identical with that obtained, more laboriously, by measuring the velocity at a number of equidistant points on the vertical and taking the average of the velocities. It is therefore needless, in future, to adopt the time-wasting method of observing a number of velocities at different points in each vertical in the cross section of the stream. It is only necessary to allow the meter to descend once along each vertical from the water surface to the bottom. Thus the whole of the measurements for a cross section can be completed in as many minutes as hours would have been required with the old form of the Woltmann meter, and the results will be more reliable, because for so short a time the general conditions of flow of the river will have remained constant. Variations of velocity due to variation of the level of the river are virtually eliminated when the Harlacher meter is used.

It is unnecessary to describe all the stages in the invention of the present form of the Harlacher meter. It is sufficient to say that Professor Harlacher worked for several years at its improvement, and that his success was acknowledged by the award at the Paris Exhibition of two gold medals.

The Harlacher meter is constructed as follows: For the movable staff on which the Woltmann meter is fixed, an immovable staff or rod is substituted, which is planted firmly in the bed of the river, and along which the meter slides up and down during the observations on any one vertical. This rod is a cast-iron tube with a solid point at the lower end A, A (Fig. 1). The other parts of the apparatus, except the electric battery and indicator, are fastened to the tube, so that the whole can be moved from one vertical to another, without having to be taken apart. The screw of the meter B is two-bladed. For very small velocities it would be preferable to adopt a four-bladed screw of larger diameter. The screw is fixed on a steel shaft b (Fig. 2) which has an eccentric enlargement at any point b_3. This makes contact with the steel spring b_4 at each revolution of the meter. These contacts complete the electric circuit, and the current which passes actuates the electric clock or indicator. The weight of the screw B, the shaft b and the brass box b_2 which carries the shaft, is balanced by a counter-weight b_5 (Figs. 1, 2 and 3). This keeps the axis of the instrument in a perfectly horizontal position. The screw b_6 serves to regulate the pressure of the spring b_4, while the two screws b_7 fasten the spring to the brass frame which surrounds and protects the shaft. The shaft is square at the end which receives the screw, which is put on and held fast by a nut b_8 (Figs. 2 and 3). The brass frame b_2 is fixed to a hollow cylinder C. Below the hollow cylinder C is a plate C_1 (Figs. 2 and 3), which prevents the instrument approaching too closely to the bed of the river, where it might be injured or retarded by obstacles. In the interior of the cylinder C there is a cylindric case c_2 (Figs. 3, 4 and 5), in which a brass spring is fastened, and through which the pin c_3 is carried. To this pin the end of the suspending rope D is fastened. The internal diameter of the cylinder C is a little larger than the outside diameter of the hollow rod A on which it is to slide. The part c_2 to which the rope is attached is connected with C by an arm which passes through a vertical slit in the hollow rod A. Thus, the instrument is kept always, if the pipe A is properly placed with its axis normal to the plane of the cross section. The cylinder C is also fitted with rollers c_5 c_6, which renders the motion of the fixed rod easy. After the instrument has been placed on the rod or staff, a bracket E (Fig. 1) with a pulley e_1 is attached at the top, and the rope is carried over this pulley. The rope D is wound on a barrel F. This barrel is fixed with the frame f_1 and the pin f_2 on the arm G (Figs. 1, 6 and 7), which is firmly fastened to the hollow rod A. With the barrel is connected the apparatus f_3, registering the depth at which the meter is at any moment. The fan f_4 and gearing f_5 regulate the rate of rotation of the barrel and permit the adjustment of the speed of the meter in its descent along the rod A. By the handle f_6 the meter is again raised. The lever f_7 and ratchet wheel f_8 (Fig. 6) arrest the rotation of the barrel. The movement begins as soon as the ratchet is lifted by the lever. On the frame of the barrel F are fastened the contact screws 1, 2, 3 (Figs. 1, 6 and 7), for attaching the wires of the electric circuit. The screw 1 is connected with the rope D, which is a copper-wire rope, covered with insulation material. The rope is in electric contact with the shaft of the screw through the spring C_2,

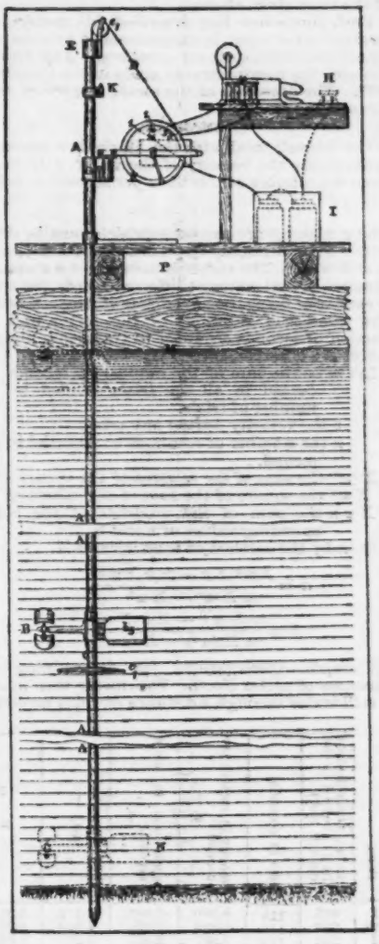

FIG. 1.

FIG. 2.

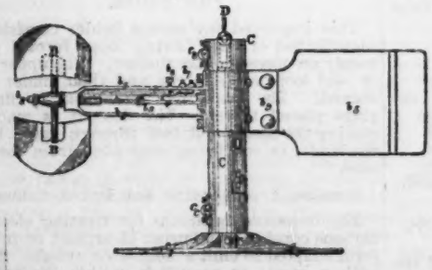

FIG. 4.

FIG. 5.

FIG. 3.

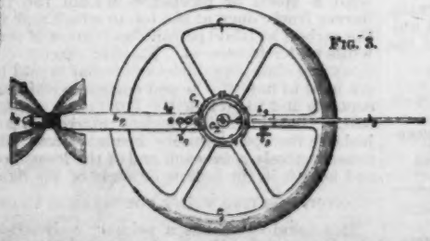

FIG. 6.

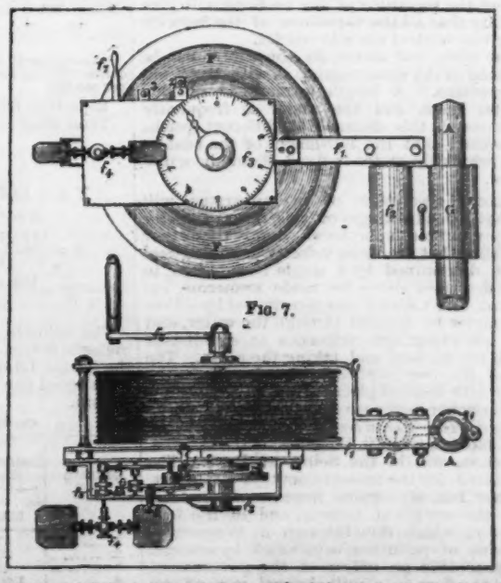

FIG. 7.

* By Richard Blum, City Engineer, Leipzig. From selected papers of the Institution of Civil Engineers.

(Fig. 5), because an insulated wire C_7 (Figs. 5 and 3) connects the lower end of the pin C_6 and the loop of one of the screws b_7 (Figs. 2 and 3), which fasten the spring to the brass frame b_2. The other conductor is the cast-iron pipe A which is in contact with the rest of the apparatus through the parts C, G, f_1, f_2, and F (Figs. 6 and 7). These parts are connected with the screw 2 (Figs. 1, 6 and 7). By putting a wire into the loop of screw 3 the depth of the meter below the water-line can be registered electrically. The registering apparatus H (Fig. 1) has two dials, one marking single revolutions and the other hundreds of revolutions.

If desired, a recording arrangement can be added, the rotations of the meter being marked on a slip of paper in the same way as in a writing telegraph or chronograph. Prof. Harlacher used this arrangement in determining the variation of velocity at a given fixed point. The battery I and the clock, or indicator H with the rod A carrying the meter, are placed on a float P. The sight vane K is fastened to the rod A so that it is parallel to the plane of the cross section, and then the axis of the screw is normal to the cross section and parallel to the current. The float is anchored in large rivers and fastened to guide ropes or poles in smaller streams. As soon as the work at one vertical of the cross section is finished, the anchor ropes on one side are slackened and on the other tightened, so as to bring the float into a new position in an easy and a speedy manner. The float must be built so as to be capable of supporting four or five persons.

The determination of the mean velocity at one vertical, by allowing the meter to slide once from the surface of the stream to the bottom, is accomplished thus: The meter B, and all its connections C, c, etc., are brought to within a few inches of the water surface, the fingers of the electric clock being set at zero. Then the barrel F is released by the lever f_7 (Fig. 6). As soon as the axis of the screw touches the water surface a signal is given, the electric clock is brought into the circuit by a spring lever, and begins to count the rotations of the screw. It is necessary to commence with the meter some small distance above the water surface in order that it may acquire the proper descending velocity previous to the counting of the rotations. In a certain number of seconds the meter descends from M to N (Fig. 1), having at each point in its descent acquired the velocity of rotation corresponding to the velocity of the water at that depth. Dividing the number of revolutions by the number of seconds, the rate of rotation corresponding to the mean velocity at that vertical is found. The fact that the disk c_1 (Figs. 1, 2, and 3), prevents the meter from descending exactly to the bottom, entails a small correction. This correction, however, will be more insignificant the larger the difference of the heights MN and NO, that is, the deeper the river in which the observations are made. It is a matter of course that the readings of the instrument at each vertical should be repeated, and the average of the results taken for the true mean velocity. The results of single measurements will not differ much from each other, but the repetition of the readings will give a certainty that all the variations of the velocity at the given vertical are allowed for.

Before using the meter, its contents must be determined in the same manner as with the Woltman apparatus. A length is marked out in a still-water basin, and the meter is frequently moved through this distance at different speeds. It is essential that the movement of the boat or float on which the meter is fixed should be a uniform one.

The above description of the apparatus will prove that the advantages of this form of meter are of considerable importance. Before the author was satisfied that the mean velocity in one vertical could be determined by a single observation, in the way described above, he made numerous experiments. The velocity was ascertained by allowing the meter to descend through the water, and also by observing the velocities at equidistant points on the vertical and taking the mean. The results of the two methods differed only in the fourth or fifth decimal place.

The Harlacher meter may be employed in large and deep rivers. The inventor has used it in the Elbe and Moldau rivers in Bohemia; in the Danube, near Vienna, and in the Seine, at Paris. The time required for the measurements is very short. The author has, at various times, made observations in the sewers of Leipzig, and in the four small rivers which flow through it, to ascertain the amount of pollution occasioned by sewage. In the year 1878 an officer of the government measured the flow in a mill channel, part of one of these four rivers, with a Woltmann meter. It took seven hours to record the necessary results. In the author's investigations on the four rivers, at points lying at an extreme distance of 3,000 yards apart, twelve hours were required, when determining the mean velocity both by allowing the instrument to slide down through the water, and by noting the velocity at every 2 inches of depth. For those observations in which the mean velocity was determined by allowing the meter to descend through the water only, six hours and a half were required for the four rivers, the measurements being repeated at each vertical three to ten times, according to the velocity of the stream. Further, the transport of the float from one cross section to another occupied in all about one hour of the time given above.

Prof. Harlacher has described his meter in a treatise* which can be recommended to every engineer interested in these questions. This treatise contains the measurements made in the Danube in 1878. The drawings of the meter are taken from this work.

APPENDIX.

The formula used with the Harlacher meter for determining the velocity of the water v from the observed number of rotations per second n, is [1]—

$$v = \alpha + \beta n,$$

where α and β are constants which must be determined by preliminary experiments with the meter in still water. The meter is towed over a measured distance in still water at different speeds, the speed in each trial being, however, as uniform as possible. The number of rotations of the meter, and the number of seconds occupied in traversing the distance, are observed accurately.

Let m be the sum of the number of seconds occupied in all the trials divided by the number of trials.

v the velocity during any trial.

n the number of rotations in any trial in one second.

$\Sigma(n^2)$ the sum of the squares of the values of n.

Σn^2 the square of the sum of the values of n.

$\Sigma v n$ the sum of the products of the corresponding values of v and n.

Then by the method of least squares—

$$\alpha = \frac{\Sigma n^2 \Sigma v - \Sigma n \Sigma n v}{m \Sigma n^2 - \Sigma n^2}.$$

$$\beta = \frac{m \Sigma n v - \Sigma v \Sigma n}{m \Sigma (n^2) - \Sigma (n^2)}$$

Example.—Observations for determining the constants of meter No. 1. The meter was moved in still water through a distance of 102.5 meters.

Number of observations.	Number of revolutions registered by the electric clock	Time in seconds.	Velocity in meters per second. v.	Revolutions in one second. n.	n^2.	nv.
1	235	115	0.890	2.043	4.174	1.818
2	232	116	0.890	2.000	4.000	1.780
3	232	113	0.907	2.053	4.215	1.862
4	231	130	0.788	1.776	3.154	1.399
(5)	234	105	0.976	2.228	4.964	2.174
6	236	113	0.907	2.088	4.359	1.893
7	229	121	0.847	1.892	3.579	1.602
8	230	125	0.820	1.824	3.327	1.466
(9)	222	148	0.692	1.500	2.250	1.038
(10)	213	137	0.748	1.700	2.890	1.272

[1] According to Harlacher this formula is sufficiently accurate with his meter for velocities not less than 0.3 meter per second.

Rejecting trials Nos. 5, 9 and 10, then

Total time = 833 seconds.

$$m = \frac{833}{7} = 119.$$

$$\Sigma n = 13.676; \ \Sigma v = 6.049 \ \Sigma n^2 = 187.03.$$

$$\Sigma (n^2) = 26.808 \ \Sigma n v = 11.82.$$

$$\alpha = \frac{187.03 \times 6.049 - 13.676 \times 11.82}{119 \times 187.03 - 187.03} = 0.439.$$

$$\beta = \frac{119 \times 11.82 - 6.049 \times 13.676}{119 \times 26.808 - 26.888} = 0.4189.$$

The following is an example of the use of the meter to determine the discharge of a small stream, the Kleine Luppe, the meter being lowered at uniform speed from the surface at the bottom of the stream.

OBSERVATIONS AT VERTICAL NO. 3.

Observations.	Register on Dial of Electric Clock. At beginning.	At end.	Revolutions of meter.	Time in seconds.	Revolutions per second.	
1	815	871	56	66	0.849	
2	871	941	70	67	0.957	
3	941	1,003	62	66	0.939	
4	1,003	1,068	65	66	0.983	Mean
5	1,068	1,135	67	69	0.971	0.9275
6	1,135	1,201	76	74	1.027	
7	1,201	1,259	58	71	0.819	
8	1,259	1,325	66	78	0.846	
9	1,325	1,392	67	70	0.957	

Hence $v = 0.4323$ meter per second.

* "Die Messungen in der Elbe und Donau und die Hydrometrischen Apparate und Methoden des Verfassers." Von A. H. Harlacher. 4to. Plates. Leipzig, 1881.

OBSERVATIONS AT VERTICAL NO. 4.

Observations.	Registered on Dial of Electric Clock. At beginning.	At end.	Revolutions of meter.	Time in seconds.	Revolutions per second.	
1	1,392	1,536	134	92	1.456	
2	1,536	1,690	154	102	1.509	
3	1,690	1,829	139	91	1.529	Mean
4	1,829	1,981	152	93	1.634	1.5492
5	1,981	2,131	150	92	1.630	
6	2,131	2,271	140	91	1.537	
7	2,271	2,409	138	89	1.550	

Hence $v = 0.6427$ meter per second. The mean velocity in the section of the river between verticals 3 and 4 is therefore $\frac{1}{2}(0.4323 + 0.6427) = 0.5275$.

These observations were taken in 26½ minutes, including the time required to shift the float and meter from one vertical to the other.

In the Danube Professor Harlacher has used the meter in a depth of 8 meters (26¼ ft.), and the water there had the great velocity of 3 meters (9 ft. 10 in.). The hollow rod used in this case had a diameter of 50 millimeters (1.92 in.). Professor Harlacher thinks that if the velocity does not exceed 2 meters (6.56 ft.), a rod of that size would be strong enough for depths of 20 meters (65.6 ft.). The only problem to solve would be to connect the pieces of which such a rod must consist.

Professor Harlacher has investigated the variations of velocity in a stream by placing five meters at equal distances apart on the same rod. The meters recorded every revolution independently by means of an electric chronograph.

RECENT INVENTIONS.

RAILROAD TIE.

The tie or sleeper is made of iron and consists of a flanged base plate, and semicircular adjustable bearing plates resting therein and having depressed chairs. The bearing plates are adjustably secured in the base plates. A clamp extends around the bottom of the chair and over the base of the rails. Angular fish plates recessed to form tongues at their outwardly projecting parts are adapted to be sprung into the bearing plate, and thereby secure the rails.

WATER-METERS.

I see that the Union Water-Meter Co., who advertise in your columns, have issued a very recent patent on water-meters, which is designed to perfect their already highly satisfactory meter. It was found that, in the use of rotary piston meters, the only tendency to leak was at the ends of the pistons. The principal purpose of this improvement is to prevent such tendency, and it consists in forming the ends of the blades and segmental bearings which constitute the co-acting pistons, with grooves or depressions. This arrangement provides an efficient water packing between the ends of the pistons and the adjacent walls of the meter shell. The invention comprises other details of improvement, comprising a novel deflector for the water as it enters the casing, etc.

FIRE ESCAPE.

This improved fire escape ladder consists of a metallic rod or wire having loops formed alternately on opposite sides thereof. The upper sides of said loops are straight and their under sides curved. The loops may be braced by flanged rings placed therein. The descent is made by placing the hands and feet through these loops, the ladder or rod being suspended from the cornice.

FORMING AND TREATING ELECTRICAL CARBONS.

This improved apparatus for treating electrical carbons consists of a burner of argand or tubular form adapted to emit a hollow or tubular flame, with a space or receptacle within the tubular burner freely open at the top to admit and inclose the carbon loop and permit observation of the same while under treatment. Electric circuit connections and clamping devices external to said burner are used to hold the looped carbon within said receptacle and to include the same in an electric circuit. These clamping devices referred to are adjustable forceps mutually insulated and adapted to respectively seize each end of the looped carbon and hold it in the hollow or gases of the flame.

COMPENSATING VALVE FOR WEAR IN USAGE.

This novel valve has a primary valve-disk, exposed around its sides, and provided with the ordinary screw-rod valve-stem. This valve disk has a definite depth and range of wear. The valve-seat has a corresponding deep depressed cavity or socket to receive and envelop the said disk. A secondary seat is formed around the upper edge of said socket to meet with a secondary valve-rim on the holder of said disk when the latter reaches the limit of its wear in the primary seat. The valve-disk is flexible and non-metallic, and of cylindrical

form, having a rounded base. The seat or socket corresponds thereto.

CAR LABEL-HOLDER.

This improved label-holder consists of a plate, provided with arms for holding a clamp. This clamp coils around each of the arms, forming springs, and extends vertically therefrom and passes through the plate, where it terminates in spurs adapted to receive the label on the front face of said plate, where it is held by the clamp arms.

RAILWAY SIGNALING APPARATUS.

In this improvement vertical swinging spring-held levers carry pulleys on their pivots, around which pulleys pass reversely around cords which operate the signal flags. When set to "danger," alarm levers are brought into position, to be actuated by a following train in case it enters the "block" before a preceding train has left it. Each train upon leaving a block resets the signals to "safety." F. B. BROCK.

WASHINGTON, D. C.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 135.

CCXCI.—ST. CATHARINE'S.

St. Catharine's, Ontario, Canada, in lat. 43° 5′ N., long. 79° 15′ W., is on the right bank of Twelve Mile Creek, four miles from Lake Ontario, and at a general level of 120 ft. above its surface, on a plain gently sloping to the north about 200 ft. below the upper plateau of the Niagara escarpment, which runs parallel to the lake shore, and six to seven miles distant from it. Artesian wells of tonic mineral waters give celebrity to the town. In 1846, the population being about 2,000, the Board of Police built small water-works, mainly for fire protection, taking water from the Welland Canal, above the town, and conducting it by wooden logs to a reservoir on Church street. The distribution was by logs of 3-in. and 4-in. bore. The pipes were too small, and were not well cared for, and the works were soon abandoned. In 1876, water-works were built by the town, after the plans of Thomas Monro, C. E., taking the supply from Beaverdam Creek, four miles from the city, and 165 ft. above it. The water-shed is about 12 sq. miles of heavy clay soil overlying limestone rock on steep sloping hillsides. Just above De Cews Falls an earth dam about 650 ft. long and 30 ft. in extreme height, with a puddled core, forms a reservoir covering 60 acres. A leak appeared in this dam in 1879. It was found to be in the old creek channel, through seams in the limestone rock. Bags of Portland cement were lowered from rafts and then filled over with good puddling material. This stopped the leak. The report of 1879 states that the whole bank for 300 ft. is composed of treacherous material.

Another dam of earthwork is built across the stream 1,800 ft. farther up, forming a reservoir of 10 acres area. A waste channel conducts the surplus water from this reservoir, around the lower one and into the stream. Both dams had settled considerably in 1880.

The water is conveyed to the city by a 20-in. cast-iron pipe, which descends the face of the mountain for half a mile, and then reduced to 16 in. continues for 3½ miles. The reservoir is 285 ft. above Lake Ontario, and 165 ft. above the highest point in the city.

Distribution is by cast-iron pipes, of which there were laid on January 1, 1881, 11½ miles of from 12 to 4-in. diameter, with 123 fire hydrants, 129 gates and 546 taps. In order to encourage the use of water the services were at first laid from the main to the street line, by the city, and no charge was made for water. Since April, 1879, water rates have been charged. Iron service pipes are used.

The total cost of construction to January 1, 1879, was $263,070.90. The cost of maintenance in 1879 was $2,868.12, and in 1880 was $1,683.79. The revenue from water rates was $2,890.69 in 1879, and $4,245.65 in 1880. The population is 15,000. The consumption is not stated. The works are managed by a board of six Commissioners. J. Albert Mills is the Superintendent.

CCXCII.—ST. PAUL.

St. Paul, Minnesota, in lat. 44° 57′ N., long. 93° 5′ W., lies on the northwest bank of the Mississippi River. The bottom lands, submerged in extreme high water, are about three-quarters of a mile wide. The bluff of limestone, underlaid by sandstone, rises abruptly about 100 ft. to a terrace half a mile wide, backed by a range of drift hills rising to 250 ft. above the river. Towards the eastern end of the city, Phalen's Creek enters the river through a ravine.

Settled in 1838, it was incorporated as a town in 1849, and as a city in 1854.

Water-works were built by a private company in 1870, taking the supply from Phalen Lake, the headwaters of the creek, 176 ft. above low water in the river, and 4 miles from the city. This lake is connected by channels, some natural and some excavated, with 19 other lakes. The company has the right of flowage from 1 to 4 ft. on 9 lakes, with an aggregate area of 2,436 acres. In 1878 the inlet stream to Lake Phalen froze solid to the bottom for six weeks.

Water is drawn from the lake by two submerged wooden conduits, extending 300 ft. into 15 ft. water. A 24-in. stoneware pipe and a 16-in. cement pipe convey the water 7,000 ft., when they unite in a 16-in. wrought-iron and cement pipe, leading 15,700 ft. to the city.

The distribution is by 12, 6 and 4-in. pipes, of which 17½ miles are laid, with 188 fire hydrants, 1,817 taps and 129 meters. Four-tenths of the pipes are of wrought iron and cement, and six-tenths of cast iron.

The population in 1880 was 41,498. The daily consumption is about 1,000,000 gallons.

No financial statistics are furnished. John Caulfield is the Superintendent.

The transfer of the works to the city, or the construction of new works by the city have been under consideration of late.

CCXCIII.—BRADFORD, PA.

Bradford, Pennsylvania, in lat. 41° 55′ N., long. 78° 45′ W., is in the oil region, at the junction of two streams forming Tununguant Creek, in the valley and on the slopes which rise to 500 ft. above the creek. It is 1,444 ft. above sea level. Settled in 1840, it was incorporated as a city in 1879. Water-works were built in 1877 by a private company, taking the supply from the west branch of Tununguant Creek, the water-shed of which is 28 square miles, and pumping directly into the mains by 2 Cameron steam pumps of 9-in. bore. A wooden tank, holding 50,000 gallons, is used to equalize the pressure. The ordinary pressure maintained is 110 lbs. and the fire pressure 225 lbs. at the pumps. Distribution is by wrought pipe, in 16-ft. lengths. There are 4½ miles in use, of from 4 to 2-in. diameter, nearly 3 miles being of 3-in. There are 13 fire hydrants, 70 gates and 350 taps. The city does not pay for use of hydrants. Wrought-iron service pipes are used.

The population in 1880 was 8,759. The consumption is not given.

The capital stock of the company is $6,900. The works have cost $25,000 and the receipts have been $35,000. There is no debt. The expenses in 1880 were $5,000 and the receipts $7,500.

S. W. Vandersaal is the Secretary.

CCXCIV.—MOUNT HOLLY.

Mount Holly, New Jersey, in lat. 40° N., long. 74° 33′ W., is on Rancocas Creek, on generally level ground, with hills in the vicinity. It was settled in 1680. Water-works were built in 1846 by a private company, taking the supply from Rancocas Creek, and pumping it 105 ft. by a Worthington duplex pump of 600,000 gallons per day capacity, into a reservoir in excavation and embankment, 100 by 50 ft. and 15 ft. deep, with a partition wall dividing it into two parts.

Distribution is by 8 miles of cast-iron pipe of from 6 to 3-in. diameter, with 39 fire hydrants. The number of taps is not given. The town pays $5 per year for each hyd ant.

The population in 1880 was 4621. The consumption is not stated.

The capital stock of the company is $15,000. The works have cost $30,000. There is no debt, and a surplus on hand of $1,600.

The expenses in 1880 were $2,500, and the receipts $4,821.65.

Henry C. Risdon is the Secretary.

CCXCV.—STROUDSBURG.

Stroudsburg, Pennsylvania, in lat. 41° N., long. 75° 8′ W., is on Broadhead Creek, which affords a good water-power. It was settled in 1779.

Water-works were built by a private company in 1876, after the plans of J. Albert Cloud, M. D., taking the supply from springs 1 mile from the town, to which the water is conveyed by gravity through a 6-in. cast-iron pipe. Distribution is by 3 miles of 6, 4 and 3-in. cast-iron pipe, with 15 fire hydrants. The number of taps is not given. The town pays $346 per year for use of fire hydrants. The population in 1880 was 1,860. The daily consumption is not known.

The capital stock of the company is $15,000. The works have cost $16,000 to the present time. There is no debt. No further financial statements are given.

P. S. Williams is the Secretary and Frederick Phillips the Superintendent.

CCXCVI.—FORT DODGE.

Fort Dodge, Iowa, in lat. 42° 30′ N., long. 94° 13′ W., is on the Des Moines River.

Water-works was built in 1881 by the city, after plans and under the superintendence of Thomas N. Boutelle, C. E. The supply is taken from the gravel in the river bottom, through a circular, plate-iron tank, 20 ft. in diameter, sunk in the river bed, closed at top and open at bottom. This has yielded 500,000 gallons per day. From this tank, or filter, the water flows into a pump-well, whence it is pumped directly into the mains by two horizontal Cope & Maxwell pumping-engines, with 16-in. steam and 10-in. water cylinders of 24-in. stroke. There is an independent 14-in. pipe from the well to the river, closed, except when the draught exceeds the capacity of the filter, when the river connection is automatically opened.

Distribution is by 1½ miles of cast-iron pipe of from 10 to 4 in. diameter, with 19 fire hydrants. The number of taps is not given.

The population in 1880 was 3,700. The consumption is not stated. The works cost $20,400. No further financial statements are given.

S. T. Meserney is the Chairman of the Water Committee.

CCXCVII.—TARRYTOWN.

Tarrytown, New York, is on the Hudson River, 25 miles from New York City, on ground sloping steeply from the river to a height of about 300 ft.

Water-works for fire protection were built in 1877 by the village, after the plans and under the superintendence of Charles E. Fowler, C. E.

A Woodward steam pump, with 12-in. steam and 5-in. water cylinder, pumps water from Andre Brook, 300 ft. into a reservoir 50 by 40½ ft. and 18 ft. deep, excavated in rock, lined with brick and covered with four brick arches of 9-ft. span and 3-ft. rise, springing from three pairs of rubble-stone piers. The arch is covered with 1 ft. of earth. The water of the brook is filtered through sand and gravel before entering the pump well.

Distribution is by 2½ miles of 8, 6 and 4-in. cast-iron pipe, with 15 double-nozzle fire hydrants.

The works cost $16,500. In 1881 an artesian well of 8-in. bore was sunk 600 ft. to procure water for domestic use. It yields 5,500 gallons per day when pumping from a depth of 200 ft.

No further information has been given. The population in 1880 was 4,514.

CCXCVIII.—ROCKLAND.

Rockland, Maine, in lat. 44° 7′ N., long. 69° 6′ W., is on Owl's Head Bay on the Atlantic Ocean.

It was incorporated as a city in 1854. Water-works were built in 1851 by a private company. The supply is taken from a lake and pumped directly into the mains by a Holly pump erected in 1869 and driven by water power. An ordinary pressure of 30 lbs. is maintained. In 1878 distribution was by 33 miles of wrought-iron and cement pipe, with 10 fire hydrants. The city exempts the company from taxation in consideration of fire protection.

The number of taps and items of expenses and receipts are not given.

The capital stock of the company is $106,850. The population in 1880 was 7,650.

N. T. Sleeper is the Secretary and John Howard the Superintendent.

[TO BE CONTINUED.]

The receipt of statistics, as follows, is acknowledged with thanks: From J. Opperman, C. E., statistics and water rates of the water-works of Bradford, Pa. There are no water-works in Bristol, R. I.

BIDS RECEIVED FOR WATER-WORKS CONSTRUCTION.

From Chester B. Davis, C. E., Chief Engineer of the Madison, Wis., Water-Works, we have received a copy of the report by the committee to the Common Council on the bids received for work and materials for the proposed system of water-works. The amount of material bid for, in whole or in part, aggregates about 950 tons in weight. The pipes are of the following description:

17,000 ft. 4-in. pipe	20 lbs. to a foot
32,000 ft. 6-in. pipe	31 lbs. to a foot
6,000 ft. 8-in. pipe	42 lbs. to a foot
1,750 ft. 10-in. pipe	60 lbs. to a foot
1,025 ft. 14-in. pipe	100 lbs. to a foot
480 ft. 16-in. pipe	130 lbs. to a foot

We quote as follows:

"The awards recommended herein are summarized as follows:

Cost of valve-boxes	$300.00
M. Philbin & Co., pipe-laying, etc.	13,370.90
Cincinnati & Newport Pipe Co., pipe	37,634.46
R. D. Wood & Co., hydrants	2,900.00
Ludlow Valve Co., valves	1,268.20
Total cost for street work	$55,473.56
Engineer's estimate for same work	56,500.00
Difference	$1,026.44

"The combination bids for doing all the work and furnishing all the materials, or a part of said work and materials, were as follows:

R. D. Wood & Co., pipes, hydrants and valves	$42,570.00
Truman Cowell, pipe, pipe-laying, hydrants and valves	50,150.00
McRitchie & Nichols, pipe, pipe-laying, hydrants and valves	56,876.41

"John F. Gray has submitted a proposal to dig the wells, one or more, 6-in. bore, and furnish all tubing and material, for $2.25 per foot, for a distance of not less than 650 ft., and not to exceed 1,500 ft. This proposal the committee recommend should be accepted, as the lowest and best bid."

The Water-Works Committee and the Engineer were instructed by the Council to close contracts with the successful bidders.

ENGINEERING NEWS.

GEO. H. FROST.....PROPRIETOR.

Tribune Building, New York City.

JULIUS W. ADAMS, *Past President A. S. C. E.*, EDITOR.
S. D. V. BURR. ....ASSOCIATE EDITOR.

SATURDAY, MAY 6, 1882.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

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Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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NOTICES OF MEETINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—ANNUAL CONVENTION, WASHINGTON, D. C., MAY 16, 1882.—The Annual Convention of the Society for the year 1882 will be held at Washington, beginning Tuesday, May 16, 1882. Sessions for professional discussion and one for the transaction of business will be held. At one of the sessions, the annual address will be delivered by the President, Mr. Ashbel Welch.

The general arrangements for the Convention are now in preparation, and will be announced. Details of the programme are in charge of the local committee at Washington, the chairman of which is Col. Thos. Lincoln Casey, Corps of Engineers, U. S. A., Director Am. Soc. C. E.

The families of members are invited to accompany them.

AMERICAN INSTITUTE OF MINING ENGINEERS—PRELIMINARY ANNOUNCEMENT OF THE COLORADO MEETING.—The next meeting of the Institute will be held in Colorado, beginning in Denver on Monday, Aug. 21, 1882. A week or ten days will probably be spent in the State. A subsequent notice will give the detailed programme of the meeting and the arrangements which may be made with railroad companies for excursion rates to Denver. It is necessary that the Secretary should have in good time the names of the members and associates who expect to attend the meeting, with the number of ladies who will accompany them.

It is desirable that there should be a large number of papers presented at this meeting, and members are requested to send the titles of their papers to the Secretary as soon as they can.

R. P. ROTHWELL, President.
27 Park Place, New York City.
RICHARD PEARCE,
Chairman of Local Committee, Denver, Col.
T. M. DROWN, Secretary.
EASTON, Pa., April 28, 1882.

MALARIA—WHAT IS IT AND WHENCE ITS SOURCE?

This term, we believe, was first used in connection with the emanations from the low lands of that district of Italy extending from Leghorn to Terracino, and from the sea to the Apennines. The term has now become of general application to deleterious emanations from decaying organic matter of any description, while the term miasma is now more restricted to the emanations from marshy lands and stagnant waters which are fruitful in producing various forms of intermittent and remittent fevers. Malaria has been called the modern Proteus, varying in character as influenced by local conditions, temperature, place and time; adopting any form that accommodates it to prevalent influences; mingling its characteristics with those of almost every human malady and modifying their essential features. Position and environment do not bar its progress. It occupies alike reeking bog and marsh, valley or hillside, flourishing alike upon arid plains and deserts, nor disdaining the dry precincts of a granite quarry perched high among the hills. Climate affords but little check to its progressive march, and the character and form of its attacks are as various as the localities. Can we wonder then that so little being known of it beyond its effects, its presence may be, and is, assmed as the cause of a host of diseases having but little to appearances in common with each other, but all susceptible, at least, of modification through its influence. Disbelief in its existence, even as a source of disease, has become extended by reason of the readiness of the modern practitioner to attribute to the influence of malaria any disease brought to his notice the pathology of which is at all obscure.

A paper on the comparatively recent appearance of malaria in Connecticut, a section of country heretofore enjoying the reputation of high healthfulness, appears in the Fourth Annual Report of the Connecticut Board of Health for 1881, from the pen of C. W. Chamberlain, M.D., the Secretary to the Board; and the answer to queries addressed by him to the medical profession practising throughout the State gives the local information bearing upon this subject. From this source we quote very briefly from a few towns, not by any means aiming to epitomize the report, which is exhaustive and highly interesting, but simply to give so much as shall indicate to our readers the subtle character of this foe to health, and the necessity that every individual shall to a greater or a less extent inform himself of what is known of the sources of malaria, that his own local observations may be of use in increasing the general store of knowledge upon the subject, for unlike many branches of science, this is not one "where a little learning is a dangerous thing;" but great results may flow from apparently very inadequate means and limited observations.

The reports from the various towns of the State of Connecticut are very interesting, and in many cases curious, and, according to Dr. Chamberlain, "generally disprove the necessity of marshes or vegetable decomposition for the production of malarial poison, however they may favor its continuance."

Of 40 towns in the State, out of 140 from which reports have been received, malarial fever appeared first upon the high land; in four of them, upon the highest land in the place.

New Haven.—About 1875 a freshet carried away the tide-gates at the mouth of Nest River. For the first time in this century the salt water inundated one or two square miles of fresh meadows, killing the trees and all vegetation. The gates were not replaced for two or three years. Vegetation was almost wholly destroyed. When the gates were replaced, and the water receded, large amounts of vegetable deposits were left, including dead trunks of trees. Here we have, on a large scale, one of the most favorable conditions for the development of malaria, according to the writers, nor was the germ or particulate of malarial fever wanting in the region threatened, yet there was no epidemic of malarial fever resulting therefrom.

Naugatuck.—I have lived the most of my life in this town and never heard of any one having chills and fever, until 1865, when I came home from the war, and then I knew of none except in cases of returned soldiers. In 1872 or 1873 I began to hear, more or less, of dumb ague and malaria, and since then both have been apparently on the increase in this locality.

Stratford.—As near as I can learn, intermittent fever first appeared here on *high ground*, about a quarter of a mile from a marsh. Malarial diseases are constantly increasing in frequency. Those living near the low-lying, salt meadows seem to be more exempt than those living far away.

New Canaan.—Intermittent fever first originated here about 1870. The first cases were of persons living upon low ground near streams. Its appearance was gradual from the towns bordering on the Sound, and was three years in reaching the village, following the stream at the rate of two miles yearly. On it went, northward and inland more slowly, but by steady steps for years, until out of my jurisdiction. I know of no local conditions about ponds, dams or streams, that differ materially from their condition fifty years ago. In general, the well-fed, well-to-do classes are less affected, while the hard laborers suffer most.

Trumbull.—Tertian in 1874, on the highest ground in the town. No local causes to induce malaria—no changes of land or water from the condition that had existed many years. Malarial diseases since 1874 have generally prevailed, affecting all ages.

Stepney.—There is absolutely no cause to account for the extensive prevalence of malaria in this region, which has affected nearly every inhabitant. All the old theories about its causation have been badly damaged by the manifestations in the recent outbreak. There has not been a dam constructed for fifty years. Typhoid fever, very prevalent ten or twelve years ago, is steadily diminishing—no case in three years part.

Bloomfield.—Intermittent appeared first 1875. Town occupies a level sandy plain, but few hills and but little meadow or swampy ground. The locality had no influence in inducing its appearance, as there have been no changes favorable to its production during the thirty years which I have practiced here. Whatever may be the theories in regard to marsh miasm and other recognized causes, we must admit that here it travels very independently and with very great disrespect for the rules which have been laid down for it. Malarial diseases have increased in frequency this summer, and with their increase, the decrease of typhoid fever has been regular and rapid—hardly a case for the past two years.

North Manchester.—The first cases of intermittent fever appeared here in 1878 on high ground, a half-mile from any pond or meadow. There have been no changes whatever to induce malaria that have not existed for years. The greater number of cases appeared near a low swampy tract, but this latter has existed in its present condition for a *great many years*. About 70 per cent. of all the cases I see appear to be of malarial origin, affecting all ages. Regular intermittent the prevailing type. Can find no record or history of the existence of malaria in the early settlement of the town. After investigating and watching its features closely, I conclude that vegetable decomposition alone is *not* sufficient to produce it, nor does the elevation of the land, *nor* the best sanitary surroundings protect. Telluric changes have *little* influence upon its production.

Hebron.—First case occurred in 1870, upon moderately high ground, a pond half a mile distant; no marsh or swamp in vicinity; a railroad built eight or ten years ago partly through a swamp; no natural drainage thereby obstructed, but more ague in the vicinity: no other favoring local conditions, actual or possible. About eighty or a hundred years ago people living in the vicinity of a tract of flooded land affected by fever and ague; malarial diseases appear to be increasing; less typhoid fever since the appearance of malaria. The reason for the present spread of malaria is *not* found in local conditions, but the producing cause or source has been introduced by some *general agency*, and has found. so to speak, a soil fitted to reproduce it where formerly it *did not exist*.

South Glastonbury.—No cause for the unusual frequency of malarial disease, except the unusual low stage of the river be considered such. I think the germs of malaria reach Connecticut from the flats of New Jersey, and, passing along the coast as they meet the streams, follow their course. This used to be a hot-bed of typhoid fever, but for the past ten years there have been but few cases.

Wethersfield.—Since the prevalence of malaria typhoid fever has been rare, and consumption far less frequent. No local cause to produce malaria. There have been no changes for years, with the exception of the construction of the Valley Railroad; *but malaria was already there*, and its prevalence no greater near the railroad than elsewhere.

Newington (formerly part of Wethersfield).—Same general condition prevalent here. As it lies back from the river, there are no lands to be overflowed, except near small streams. Hills more abundant, and the dwellers thereon equally affected with those on the low lands, but not as severely, nor the cases so persistent.

Rocky Hill.—First case in 1872 of typical intermittent, occurr ng on high ground entirely away from the vicinity of marshes, ponds or streams. During the summer there were four cases near a mill pond, which was in the same condition that it had been for seventy-five years. Do not believe that the local surroundings have had anything whatever to do with malarial diseases in this town. Do not know of any disturbances or conditions out of which malaria could be evolved. Have no possible causes capable, of generating that hypothetical factor denominated marsh miasm that has not been present with us for the past hundred years. Have two mill ponds in lower part of the town on the same stream. They have been in the same condition as at present for over a hundred years. A third pond between the two built twenty-five years ago. In the summer of 1876 the three ponds, all within a distance of half a mile, were drawn off, and the vegetable decomposition collected in them left reeking in the sun in the condition supposed to favor the evolution of paludal poison. Yet there were no cases of fever of any kind in the neighborhood, but there was intermittent in other parts of the town remote from them. Typhoid fever has been absent since malarial diseases came in. Whether the facts are simply coincident may be a matter of doubt. My opinion would be that there is some unknown relationship between the increase of intermittent and the outgo of typhoid, but not fortified by such evidence as to render it an established fact. The acceptance of the idea of the substitution of one form for the other would militate against the doctrine of specific germs as the etological factors for each special fever. The theory that there are living microscopic existences that get from the soil into the human system and produce there the phenomena of intermittent and the cognate diseases as developed by the Italian physician, Crondelli, is plausible, but it lacks confirmation.

Chetham.—Malarial diseases have been slowly creeping this way from the vicinity of Middletown and Portland. I do not think the railroad through the town had any connection with the causation of malaria, as it commenced in Portland while the

railroad was under discussion, before its construction *was commenced*. Do not see much relative difference in the number attacked, nor the severity on low, swampy ground, or on high, dry ground. It has prevailed in the most hilly districts as much as in the lowest or flattest, and five or six miles from the railroad as much as in the immediate vicinity.

Old Lyme.—First case in 1877, on low ground surrounded by marshes. Families who have paid particular attention to drainage and all sanitary measures are as violently attacked as those whose dwellings are surrounded by filth and swamps. Those who live on high hills with no swamps near are not exempt—malarial diseases have prevailed the length and breadth of the town; but few have escaped.

Middletown.—Ever since this place was settled it has been exposed to all the elements one would suppose favorable to the production of malaria. Running the whole length of the territory is the Connecticut River; on the south and southwest are ponds and streams, and the same on the north and northwest. Joining the two is an extensive marsh and swamp, leaving only a space of high land perhaps fifty rods wide to connect us with the main land of Connecticut; yet, with all these surroundings, and with only imperfect drainage, malaria was unknown for 238 years, or from the first settlement in 1635 to 1873. Since 1870, pure water has been introduced, and the city has been thoroughly sewered and now malarial diseases are abundant.

The above-named towns are selected from a large number of returns as exhibiting local peculiarities in reference to the existence and spread of malaria in the late outbreak in Connecticut. It is to be presumed that the reporting physicians were equally reliable in all cases, and we have the evidence of the danger to be apprehended from a hasty generalization based upon a few isolated facts. In other wards, we *know* absolutely nothing as to the source of malarial disease. The chemical analysis of the air of malarious swamps shows nothing having any relation to the production of periodic fevers, or at least no proven relation; and the theories to account for the source of the poison have been of the most varied character—many of which are noted by Dr. Chamberlain, but which space will not permit us to quote, further than to refer to that of Krebs and Crondelli, who attribute the poison to a form of bacteria known as *bacillus malaria*, which is figured in a plate accompanying this report as a rod-like microscopic body containing a spore at each end and sometimes one in the middle, and grows in long, curved filaments divided by joints, and so far as we can judge, analogous to, if not identical with, Professor Koch's bacillus found by him to be the parasite which gives rise to tubercular consumption, a discovery which may be characterized as the

DISCOVERY OF THE AGE!

the possibilities of which in the early future toward diminishing the ravages of diseases may prove of incalculable value to the human family. The details of this late discovery by Professor Koch, of Berlin, form the subject of a letter from Professor Tyndall to the London *Times*, a synopsis of which by the Brooklyn *Eagle* is too well conceived to be lost, and we offer no apology to our readers for laying the greater part of it before them without mutilation.

The germ theory has long been suspected as underlying many of the most serious diseases. Practical inquiry and experiment have demonstrated, beyond a doubt, that eruptive fevers like small-pox, splenic fever in cattle, and Asiatic cholera, are due to the rapid multiplication in the system of certain organic germs. Pasteur, by a series of brilliant experiments, at last succeeded in turning this revelation to account. He found that precisely as the little microscopic spore or bacillus, by being permitted to develop in the body of the ox lost its virulent properties and produced a disease in man identical with small-pox but much milder, and prevented, under certain conditions, an attack of that disorder, so the germs which cause other eruptive diseases may be modified and administered by the same process as vaccination, with certain specific results, in protecting the inoculated body. And now the crowning discovery of the age is announced by Professor Koch, of Berlin. The one incurable disease of humanity, whose victims have been numbered by millions, and which carries off one-seventh part of the whole human family, is discovered to be due to a germ like that of small-pox, typhus and cholera. The active agent of consumption has been detected. It is a little rod-shaped, microscopic bacillus, embedded in the tubercle, which does all the mischief. Dr. Koch had long pondered the subject of consumption and sought to trace it to some other source than the tubercle. He found it with the microscope; he has trained and bred it for ten generations, and found that at that distance from the parent germ it is just as virulent as it had ever been. Once inoculated with this germ, no matter how minute, the body nourishes it into active life and reproduction, the organs of the body become infested with the generations of organic life, which in their growth excite the tissues to the formation of tubercles, with the deadly consequences so familiar to us all. It is no longer believed that cold and exposure are the true causes of tuberculosis. They may produce changes in the system which will favor the development of the germs more or less rapidly, but the bacillus must be in the system originally before it can be made active in bringing about tuberculosis. It is generally understood, by the way, that half the human race is more or less tuberculous. Consumption thus shows itself today as a contagious disease. Knowing this much of its origin the scientific world is now busy in attempting to meet and destroy it.

Dr. Koch was led to his investigations of tuberculosis by the experiments made by him in the line of Pasteur's researches. How he proceeded, after detecting the bacillus—an organism of parasite so small as to be visible only under extraordinary magnifying power—and cultivating it, will doubtless be interesting. Professor Tyndall, writing to the London *Times*, describes it. Taking a speck of matter from a tuberculous human lung he infected a substance prepared by himself as nutriment for the parasite and let it develop. A minute drop of this mixture was then permitted to infect another nutritive substance, and in due time, after development, a drop of this was again used, and so on until many generations had gone by. At the end of this time minute quantities of the last mixture were injected into various animals, and in every case, without exception, they died of tuberculosis. Six guinea pigs were experimented with. Four were inoculated with a scarcely perceptible amount of a preparation of the fifth generation of the parasite and two were untouched. The four thus infected sickened and lost flesh. At the end of 32 days one died, and four days later the other three were killed. Every one of them had well-marked tuberculosis in the spleen, lungs and liver, while the two which had not been infected, when killed, were absolutely free from the parasite as well as from tubercles. Eight other guinea pigs were infected with cultivated bacilli of the eighth generation, the original being a speck of lung of a consumptive monkey. The results were identical, the disorder losing none of its virulence. Similar experiments were made with cats, rats, mice, rabbits and other animals, and injection of the fluid into the system was invariably followed by decided and in most cases virulent tubercular disease. Rabbits were injected even in the aqueous humor of the eye with the cultivated bacillus and were victims of tuberculosis, and so on through a series of patient experiments.

Another series of experiments was made to ascertain the nature of the tubercular bacillus. Unlike the splenic fever spore, it is not what might be called a hardy plant. The limits of temperature between which it can develop and multiply are 86 and 104 degrees. In the temperate zone, therefore, it cannot flourish, except in animal bodies. It can be dried, however, without being robbed of its vitality, and hence may be circulated in rooms as dust breathed into the lungs and vivified. The expectorations of persons troubled with phthisis are found to be swarming with these parasites, while those of persons not so afflicted are entirely free. An inference is, therefore, to be made that consumption, instead of being hereditary, is communicated by the germ-laden air of the patient's sick room, especially to those members of the family more especially in attendance.

So many considerations arise, provoked by this superb revelation, that one cannot give space to them. It would be interesting to know what the effect of diluted alcohol is upon the tubercular bacillus. Enlightened practitioners have already begun to administer alcohol copiously to consumptive patients, the theory being that it prevents waste of tissue, and so aids in building up new tissues. That it has this effect experience familiar to many has demonstrated. But if it is found that its specific action is to kill the parasite itself pure liquors put on another aspect from that persistently regarded by the Prohibitionists. It may yet be proved that the universal appetite of animals, from men down to rattlesnakes, for strong drink, is a dumb perception of Nature's antidote for disease germs, and if this is the case the very habit which is assailed as a curse may after all have proved to be man's salvation.

It is not too early to believe, therefore, that consumption will, within a few years, be as readily met and mastered as any ordinary malady, and it may yet happen by a modification of the tubercular bacillus or parasite, persons can be inoculated against consumption as well as against small-pox.

PERSONAL.

J. A. MACDONALD is Chief Engineer of the Orange Ridge Railroad. Offices at Sanford, Fla.

CAPT. T. Y. DABNEY, of Shreveport, La., has been appointed chief assistant engineer in charge of construction on the Vicksburg, Shreveport and Pacific.

MR. O. F. NICHOLS, Mem. A. S. C. E., for the last three years with the New Jersey Steel & Iron Co. at Trenton, N. J., has just been appointed Resident Engineer of Henderson Bridge at Louisville, Ky.

BENJ. FRANKLIN DELANO, formerly a United States naval constructor, well known before the civil war and in the early part of the conflict, died at his residence, No. 115 St. Marks Avenue, Brooklyn on the 30th ult.

COL. E. W. COLE has resigned his position as President of the East Tennessee, Virginia and Georgia Railroad Company. The Directors have elected Gen. Samuel Thomas as his successor, and Major Henry Fink as Vice-President. Col. Cole continues to be a Director of the company.

PHILIP GOLAY, C. E., in charge of the long Trestle Bridge across Lake Pontchartrain, on the New Orleans & Northeastern R. R., has resigned, and goes to take charge of the government work at Grand Chain, on the Ohio River, with headquarters at Paducah, Ky.

THE CONTINENTAL RAILWAY COMPANY, at a meeting held April 21 in this city, elected the following Board of Directors: General W. C. Kibbe, of Brooklyn; Milton Westen, of Chicago; Thos. P. Johnston, of New Jersey George H. Ely, of Ohio; W. M. Barnum, of Connecticut; C. C. Deming, C. W. Ramsey, Willoughby Weston, C. B. Hotchkiss and R. N. Funkhouser, of New York, and D. Messmore, of New Jersey. Messrs. Smith and Johnston were in the old board, and the following directors hold over: Geo. E. Yarring on, of Massachusetts; R. S. Dwiggins, of Indiana and S. D. Cousins, William Thorp, A. G. Day and J. B. Stewart, of New York.

M. HENRI GIFFARD, the well-known French engineer, who recently died, has, it is said, left the whole of his fortune, amounting to several million francs, to the French Government, to be employed in the furtherance of scientific research. Giffard is best known to the public from his connection with the great captive balloon at Paris; but his fortune was probably due, as his fame certainly was, to the invention of the injector—a small appliance used for forcing water into steam boilers and for other purposes. He died at the comparatively early age of fifty-seven, and as he was not married there are presumably no relations to mourn the loss of his munificent gift to the French nation.

GEN. WM. L. BURT died of paralysis at Saratoga, N. Y., April 2. He was born in Wilbraham, Mass., in 1809, and at an early age removed to Ithaca, N. Y. He graduated at Harvard College and the Harvard Law School, and in 1853 began to practice law in Boston. During the war he was Judge Advocate General on Gov. Andrews' staff, and took an active part in raising and sending forward troops from Massachusetts. For nearly eight years he was Postmaster of Boston. Gen. Burt early took an interest in railroads, and was the projector of the Suffolk Horse Railroad and other local projects about Boston. He was the projector and for several years President of the Utica, Ithaca & Elmira road, and later was the projector of the Boston, Hoosac Tunnel & Western, and was President of that company at the time of his death.

M. FERDINAND DE LESSEPS was feasted on the night of April 19 by his fellow townsmen of Versailles. On the house where he was born on the 19th of November, 1805, a commemorative tablet was placed in the presence of an enthusiastic gathering, and this was followed by a monster banquet. The veteran engineer ridiculed the English fear of the Channel Tunnel, which he facetiously called "the French Pipe," and prophesied it would become as great an accomplished fact as the Suez Canal. A guest having drunk to the completion of the Panama Canal, M. de Lesseps replied: "I invite you all to the opening of the canal. It will take place in 1888, and I feel convinced that I shall be there too." The ladies present were interested to learn that Mme. de Lesseps gave birth to her tenth child a fortnight before.

C. C. LOVEJOY has resigned his position as Superintendent of the New York works of the Hudson Tunnel to accept the position of Superintendent of Bridges and Buildings on the N. Y., W. & O. R. R., under Chief Engineer Walter Katté. We congratulate the latter company on the acquisition to their force of so able a man. Mr. Lovejoy will be missed at the tunnel, for he was very popular with the employés of the New York works, as was evidenced by the presentation, previous to his departure, of a handsome silver water service by the foreman and assistant foreman, and a handsome meerschaum pipe by the laborers. Mr. Lovejoy's ingenuity and aptness in emergencies are such that it seems strange he should be allowed to leave the tunnel works, where, we understand, much if not all of the successful issue of the New York work has been due to his ingenuity and untiring superintendence and watchfulness. May success attend him in his new field of labor.

PROGRESS OF ENGINEERING IN 1881.*

Gentlemen of the Western Society of Engineers:

Our Society, which originated about thirteen years ago, may be said to have passed during the year 1881 through the trials and dangers of a new birth, consequent upon the recent changes in its organization and the wider aims then adopted. Instead of being in name simply a local club, expecting a membership from but a limited territory and looking apparently only to civil engineers for accessions, it has adopted a title which will apply to more than one-half of our national domain and to all who are, or have been, employed in carrying out the principles of engineering.

The first half of the year was much taken up with the discussion of measures. The most important result has been the union now existing with the Boston, Cleveland and St. Louis societies in the formation of an association for the publication of the proceedings of the societies thus united. If the character and appearance of the numbers of the *Journal of the Association* thus far published, and the proverb, "In union is strength," can be taken as grounds of prophecy, we may predict an encouraging and creditable future for it. How shall such a journal be sustained? Money can generally be obtained by wisely directed appeals, and interesting matter for publication can be procured by compilations from existing treatises and articles of acknowledged value; but unless we can furnish for the *Journal* papers containing at least some original matter of interest in some branch of engineering, then, as far as we concerned, such a publication will fail in its most important object. The three essentials to our prosperity are increase of membership, a greater amount of income and the frequent production of articles worthy of publication and likely to be valued by engineers interested in the subjects treated. Other things are very desirable, such as permanent, well-lighted, comfortable rooms, a good reference library, and sufficient means to keep the rooms and library always accessible and serviceable to the members. If, however, we do not yet possess these things, or owing to our position with regard to kindred societies, or to our peculiar surroundings, our growth should be slower than we hoped for, we ought not to be discouraged.

Having first settled it firmly in our minds that the best interests of a large number of engineers demand an organization whose meetings should be held in this city, duty requires us to sustain such an organization. We have already a membership sufficiently large to produce many valuable papers. The character of these is what must determine our usefulness outside of our membership. "What should be our highest aim as engineers?" Should it be to stand at the head of the profession, or to scrupulously discharge the duties of the positions in which we are placed? If the former, then we have many chances of failure to one of success, which will so often depend upon circumstances entirely beyond our control. If the latter, then success depends upon ourselves; for it is assured by a simple and constant attention to the requirements of each occasion as it arises. Of course, this implies honesty not only in the discharge of duty, but in a careful preparation for it. When the attainment of the highest position is the all-absorbing or controlling motive it may lead to injustice to others, to seeking their positions, or to claiming credit not deserved. The true engineer will shrink from all of these and, as a rule, make but little if any claim to credit, leaving it to others to say what he deserves. He will occasionally discover quite a diversity of opinion on the subject, especially if the press should take it up; but if he is prudent he will keep out of the controversy.

We should be ever ready to help and advise each other, to strengthen private judgment; but this should not be carried to the point of giving to employers responsible professional advice for which they do not pay. This would not be mentioned if some cities and towns did not endeavor to get valuable advice from engineers without paying for it, when they would not expect to get it in a similar manner from doctors or lawyers.

Engineers are often depressed with a sense of injustice in regard to their pay and relative position among the officers of a city or corporation, or as compared with the members of other professions. Salaries are sometimes cut down so as to make it impossible for an engineer to live in a manner befitting his position or to properly educate his children. A remarkable instance of cutting down has been reported lately. In a city containing many intelligent and enterprising men, the office of city engineer was let out to the lowest bidder at $900 a year. No wonder the "successful competitor" is said to have employed as rodman a boy only eight years old! If a distinguished surgeon or lawyer should charge several hundred dollars for a few hours' work, it is acquiesced in as a reasonable compensation for professional knowledge, experience and ability; but if an engineer should make corresponding charges, he would excite astonishment, at least in this country. But these things cannot be changed by merely speaking against them; and there is an encouraging side. If the increasing number of engineers who have recently been placed in positions of great importance, as presidents and vice-presidents, general managers and general superintendents of railroads and other corporations, may be taken as a guide, it is not unreasonable to hope for a return to the custom that prevailed fifty years ago, and later, of giving the charge of operating completed works to those who had constructed them. At all events, such a state of things is much more likely to be brought about by the exercise of the kindly feelings and scrupulous regard to duty before mentioned among engineers themselves than by the opposite or purely selfish course. Even if promotion and pecuniary prosperity should not result, the advancement of engineering certainly would, and this means advancing the interests of mankind. To be a benefactor to one's race should be, and is by right-minded persons, considered more honorable than the mere possession of wealth or position.

In regard to the progress of engineering during the yast year, a statement of which is expected of the retiring president, it is not an easy matter to tell where to begin or where to end. In every branch of engineering there are units of measure or standards of comparison. How shall we apply them in this case? As with the heavenly bodies, actual progress can only be determined after a long series of carefully made and considered observations, so in the latter a knowledge of and careful comparisons with the past are essential to a determination of actual progress as well as its measure. If we consider the amount of engineering works constructed during the past year as evidence of progress, then it was probably greater than in any previous year in the history of the world. But mere repetition or duplication, however extensive, cannot be considered real progress in engineering any more than a multiplication of books in successive editions can be considered progress in literature. We cannot help associating with the idea of progress something new either in principle or combination. What can we find in these respects to apply to the past year? If we might look back but a little more than fifty years it would be easy indeed to prove that there has been great progress. Allusion only will now be made to recent progress in a few directions.

Descriptions of most of the works now in progress or contemplated have appeared in the numerous weekly and monthly journals with which engineers are so well supplied. It would be difficult to point to a more striking evidence of the progress of engineering than the number and character of most of these journals, which could not have been sustained a few years ago.

The enormous loss of the force residing in coal when applied to useful effect through the steam engine continues to exercise the ingenuity of inventors, and the number of abandoned contrivances for saving fuel is constantly increasing. The most promising direction in which to look for a saving of some part of the great loss of force now experienced continues to be in the use of steam of higher initial pressure. This has led to increased strength of boilers; but the use of steel of excellent quality, now produced at such low comparative rates, makes it as easy and as safe to navigate the ocean with steamers having boilers bearing 100 lbs. pressure as it was with those having but 10 lbs. pressure forty years ago. Even less than the pressure of the atmosphere was advocated by naval men, so that in time of war a ball through a boiler, instead of letting steam out, would let air in. The newspapers last year published accounts of a steamer which crossed the ocean to this country, the "Anthracite," that had a boiler pressure of 300 pounds. How long it will take to introduce such a pressure generally, it is useless to speculate upon. The re-introduction of compound cylinders, so long laid aside, while not increasing the duty of the steam engine theoretically, does increase it, by making it practicable to use the expansion force of steam to a much greater extent than formerly. Actual experience has caused all the leading lines of Atlantic steamers to be provided with engines of this type. For stationary engines, such as pumping-engines, the tendency is in the same direction; but for most other purposes such a tendency cannot be claimed, the question depending upon such considerations as first cost, rate of expansion desired, and size and purpose of engine.

Substitutes for the steam engine do not appear to have made much advance. Yet at the close of a lecture recently by the Electrician to the General Post-office, London, Sir William Thomson said at Glasgow: "The steam engine was passing away and the gas engine would supply its place." Thus far progress in that direction on a large scale has been very slight. Ericsson's small caloric engines are said to be manufactured quite extensively; their extreme simplicity, being without valves, makes them very desirable for many purposes. If Sir William's views are realized, "we must look forward to the time when, instead of getting up steam, fire will be applied direct to do the work." Also that "three years ago scientific men, who should have seen such a thing beforehand, but did not, scarcely credited what has now been shown by engineers, that gas used to drive a gas engine and produce the electric light, gives much more light than when used directly."

Of the increase in the number of miles of railroad in this and other countries during the year it is impossible to speak with certainty, except to say that it exceeds that of any former year; and is therefore the most striking measure we have of the increased application of engineering works to the wants of mankind. The effects of this increase, though at once great, cannot be limited to the present. The numerous important links that are to form connections between the Atlantic and the Pacific, beginning with the Northern Pacific and going southward, not merely to the Southern Pacific, but passing over into Mexico, have made great progress.

In the crossing of mountains, steep grades continue to be adopted. By increasing the weight and number of locomotives, and resorting to tunnels when necessary and loops when practicable, it would seem as if there were no mountains in the world which might not be traversed by the locomotive. We hear of the 90-ton locomotive, including tender, on the Pacific slope. When this is compared with the 5-ton engine, considered heavy fifty years ago, we see great progress.

If no marked change has taken place in the forms of railroad equipments recently, they have been benefited by the improvements made in the manufacture of materials, especially in the use of steel, which for rails continues to show the great superiority and economy, as compared with iron, claimed for it years ago.

The enormous increase of business on the leading lines of road calls for terminal facilities in large cities not dreamed of when the railway system was commenced in this country.

No branch of engineering requires more skill and care than that demanded in some cases for the renewal or repairs of bridges on railroads over which the regular trains must not be interrupted if it can possibly be avoided. Probably the most remarkable example of this kind in our country is the late thorough repair and renewal of parts of the Niagara suspension bridge. In a recent case, where the fall of part of a bridge interrupted traffic, it is said the losses were a million dollars or more, whereas could the renewal have been made without interrupting traffic the cost would not have been $100,000.

The prevention of accidents on railroads has always called forth much ingenuity and care; yet some of the most fearful that have ever happened have occurred recently. The block system is extending and is the most certain means known for preventing collisions of trains, but its heavy expense has prevented its general adoption thus far in this country. Experiments are now in progress for determining the practicability of substituting automatic electrical apparatus to a still greater extent for a part of what is now done by men. The frequent examination of bridges has no doubt led to the prevention of many calamities, and yet several recent instances of serious accidents occuring at bridges shortly after their examination, make it painfully apparent how easy it is to overlook vital points. Accidents and failures lead to renewed study of their causes and thus advance engineering knowledge, though sometimes at a fearful cost of life and money as well as great grief and mortification to those who are held responsible for them. It is very easy to point out the defects of a structure after it has failed; but only those who point out such defects before the failure, and especially during the planning or construction of the works, deserve much praise; for after everybody becomes familiar with a fact, there is little credit in promulgating it.

One important element of danger on railroads, especially to bridges, is the gradual yet in the aggregate great increase in weight of engines and cars, and speed at which they run. Structures which originally had a large factor of safety have had it gradually diminished to nothing, not only from the causes mentioned but from deterioration or defects of materials not originally suspected, while theoretically they were still safe.

The actual progress in bridge building during the past year is said to consist, not in the discovery or carrying out of any new principles, but in the more perfect adaptation of those principles to all the parts or such structures. Decided improvement has been made in the strength of materials and modes of testing it, and the forms and proportions of parts, now considered almost perfect.

The Brooklyn suspension bridge, though not yet finished, and up to this time the most remarkable bridge in the world, having a center span of about 1,600 ft., seems likely to be eclipsed by the wonderful bridge planned for crossing the Forth, which

* Address of E. S. Chesbrough, retiring President of the Western Society of Engineers. Reprinted from the *Journal of the Association of Engineering Societies.*

has two spans of 1,730 ft. each. The novel and exceedingly bold application of principles, long known to engineers, in its plan, if carried out, will make it the most extraordinary bridge in the world.

In regard to the deterioration of material in bridges, much and rather surprising information has recently been collected in this city, the particulars of which, it is hoped, will yet be published. Structures which were planned by able and competent engineers, with whom they were a specialty, have been found unsafe, from the effect of acids escaping from the furnaces of locomotives and other engines. Dangers of this kind, like many others, when expected are easily prevented.

The subject of sewerage, so intimately connected with the health and comfort of the inhabitants of cities and towns, has probably been written about more the last year than in any preceding one; but it is difficult if not impossible to point out anything in principle or essential features that was not known years ago to engineers familiar with this branch of their profession. The separate system, now about forty years old, has come into special prominence. It seems likely to be carried to an extreme, but will no doubt furnish valuable experience. In the disposal of sewage all the methods now resorted to have been known in substance, if not in minute detail, many years. The ventilation of sewers through perforated covers into the streets is now almost universally adopted, though strongly opposed not long since.

Although nothing new in principle in this department can be pointed out, much has been recently done in the planning and construction of new works, and in collecting information concerning the experience of cities that have had them for some time. Among our own countrymen, Mr. Hering has made an exceedingly valuable contribution to our knowledge by the recent account of his observations on the sewerage works of European cities.* It is expected that a completely illustrated edition of his report will soon become accessible to all. The experience of such cities as London, Paris and Berlin should be carefully studied by the engineer who would avoid serious errors in the planning of work for our own large cities. Yet there is much, and soon there will be more, to learn from experience in this country, especially in the disposal of sewage. Among works carried out for this purpose the past year are those of Pullman, so near us and the first of the kind in the West, and the most complete in the United States. From their operation it is believed much valuable experience will be gained for this vicinity, which has its peculiar climate and soil, while much of it, like Pullman, is very slightly elevated above Lake Michigan.

In many cases the engineer is perplexed in determining what to do to provide for future extensions. This difficulty is not confined to the planning of sewerage works, but is particularly troublesome with them. It is reported the lower parts of London suffer now from the flooding of cellars by excesses of storm-water not originally anticipated or provided for, but which are consequent upon the remarkable growth of that metropolis.

Paris is gradually extending her irrigating system by encouraging farmers to use the sewage, which they find so profitable. Berlin is making satisfactory progress with her extensive, but as yet partially carried out, irrigating system. Reports speak very favorably of the salubrious condition of the farms and value of crops raised upon them. It is believed that these will soon yield a sufficient net revenue to pay a reasonable profit on the cost of the farms, together with their improvement and maintenance, but not upon the cost of the works for delivering the sewage at the farms.

Contrivances for flushing and cleansing sewers are now more perfect than ever. For the improved sewerage of Boston extensive experiments have been made with cements.† One result was the curious as well as probably important discovery that a limited addition of pulverized clay to Portland cement increased its strength and imperviousness. If this should prove to be the case with other clays, and time show no deterioration in such mixtures, they will not only reduce the cost of Portland cement mortars, but add to their value for dams and reservoirs as well as sewers. A somewhat similar discovery is said to have been made at Providence several years ago, but the subject was not further investigated there.

The remarkable extent to which water-works have been introduced into the cities and towns of our country has been shown in regard to most of them by Mr. Croes, whose descriptions of their details‡ are already well known, and, like Mr. Hering's report, will make a very valuable contribution to our knowledge, and be a work of reference for many years to come. Such papers form a safe basis for progress, and it is well that some engineers of the requisite qualifications can find time to prepare them.

The new works for supplying Liverpool with water, commenced last year, it is believed are the most important now under construction. One or two facts in regard to them are of special interest. Besides tunnels and inverted syphons, now so well known, the reservoir which is to collect the supply is to be formed by a stone dam about 800 ft. long and 80 ft. high above the surface of the ground, and extending 40 ft. below to bed rock. Although stone dams are not new, even those of much greater height than the one at the head of the Liverpool works, they have not, in this country, been much in favor for considerable heights. Occasionally one has been recommended and adopted here, but the partiality for earth dams has generally prevailed, and in many cases is justifiable. But for very high dams, where a rock foundation can be reached, investigations in Europe and in the East Indies have settled the question that stone dams are much more advisable than earthen ones. The Furens and the Ban dams, in France, each about 164 feet high, have now been constructed long enough to add the testimony of experience to that of theory on this subject.

Another fact in connection with the Liverpool water-works is this: Nothwithstanding the saving of water brought about by the Deacon system in that city, her extensive and costly new works have been commenced. This leads to a mention of the waste of water in cities generally; but there is not time to discuss it here. Yet there is nothing in connection with the management of works that calls so loudly for reform. Why cities should use from 50 to 125 gallons per inhabitant a day, when in the latter case two-thirds or more must be waste, is a very difficult question to answer on any reasonable or economical grounds, yet the attempts to prevent this waste are generally hedged about with difficulties that soon discourage or render powerless those who make them.

Hitherto electrical appliances have not been considered as coming within the special care of the engineer, but the field of invention they have already opened up has become exceedingly large, and covers a great deal that is inseparably connected with engineering works.

As a motor for locomotives or other engines, but little or no progress has been made in their general introduction except for those of very small power, to generate which steam must be used; but when water can be used, transmission of power by means of electricity to a distance will no doubt be rapidly developed hereafter. As by using the electric telegraph it is possible to do so much more business and with greater safety on railroads than formerly, so with the telephone all kinds of business are more rapidly and easily transacted between different parts of a city, and there is reason to believe this will be practicable before long between different cities. Already they have conversed through 600 to 700 miles of coiled cable, experimentally, and actually between the cities of New York and Buffalo—400 miles.

In the production of electric light we are often struck with new applications of beauty and brilliancy, especially in New York, Chicago and other cities, where some of the streets at night are made almost as light as day. By means of the electric fire alarm in Chicago, the time required to start horses and engine after the signal has been given has been reduced to less than eight seconds. Besides the rapid extinguishment of fires, electricity is proving a most efficient aid in the prevention of crime. The stranger or returning absentee is struck with the present efficient arrangement for massing police with great rapidity in any part of this city.

What to do with the telegraph and telephone wires has become a serious problem in American cities; the tendency to put them underground being on the increase. This is already done in European cities. In Paris, the sewers, which are much larger in proportion than in any other city, are utilized for this purpose.

The uses to which electricity has been and may be applied are so numerous already and increasing so rapidly that one is tempted to give strong play to his imagination in forecasting the future. By means of this wonderful agent Niagara Falls could be made to put out fires in New York and other cities; move the trains on many railroads, give light to millions of inhabitants and heat to their dwellings, besides accomplishing hundreds of other useful purposes. If the efforts now made by very able and hopeful men to store up this mighty and yet manageable force should succeed, it is impossible to set bounds to its uses. In some form or another electricity seems destined to enable men to navigate the air. When this is accomplished it will easy to do more in exploring the Arctic and Antartic regions in one year than has been done in a thousand hitherto. The geography of Africa will be known in a short time as thoroughly as that of Europe is now. It will then be possible, when commercial or other interests may require it, to make not only dwellings but clusters of houses comfortable and ornament them with tropical verdure the year round in the highest northern latitudes. Then may we reasonably expect to have a *life-saving* service along our coast that will, in connection with the telegraph, make it possible to rescue speedily the shipwrecked, and to snatch from the tops of burning buildings those who would otherwise perish. It is doubtful if the strongest imagination can equal the realities that are to burst upon us in the not very distant future of electrical appliances, which already surpass the dreams of but a few years since, which are rapidly bringing "the ends of the earth together," and breaking down the barriers that separate nations from the brotherhood a common humanity should lead us to cherish.

* Reprinted in ENGINEERING NEWS.
† It is hoped an account of these will soon be published.
‡ See ENGINEERING NEWS.

CORRESPONDENCE.

WHY IS IT?

EDITOR ENGINEERING NEWS:

The correspondent asks: The radius of a 1° curve being 5,729.65 ft., why is not the radius of a 10° curve 5,729.65÷10 ft.? Answer. The radius of a 10° is 5,729.65 ft. when distances on the line are measured on the arc. But the radius given in the tables for a 10° curve is calculated for distances of 100 ft. measured in chords, and as arcs are not proportioned to their subtending chords, the results would not be proportional, that is the radius of a 1° curve being 5729.65, the radius of a 10° curve would not be 5,729.65 ÷ 10.

A.

EDITOR ENGINEERING NEWS:

Your correspondent "Nimrod" asks the reason why the radius of a 10° curve is not exactly proportionate to the radius of a 1° curve. One would think that any person capable of asking such a question could answer it himself. The following formulæ may help him:

$$\text{Radius} = \frac{\frac{1}{2}\text{ chord}}{\text{Sin } \frac{1}{2} \text{ degree of curve}}$$

Example chord 100 ft.

$$10° \text{ curve} = \frac{50}{.08716} = 573.6$$

Required radius.

M. J. B.

HANOVER, N. H., April 20, 1882.

EDITOR ENGINEERING NEWS:

"Nimrod," in your last, asks why 5,729.65, divided by the number of the degree for which one wishes to find the radius, is not equal, I suppose, to required radius. If we let R = radius and a = angle at the center of the curve, subtended by a chord of 100 ft. or the degree of the curve (which in his first case would be 1° and second 10°) we could find R from the common formula $c = 2R \sin. \frac{1}{2} a$ where c in this case would be equal to 100 ft. From this we get $R = \frac{100}{2 \sin. \frac{1}{2} a}$.

Now, according to his reasoning, the sines of angles must vary as the angles, which is not true. For taking his example, viz., first, 1°, ½ of 1 will be 30 minutes, its sine .0087265; in second case ½ of 10° = 5°, its sine .0871557, which is not ten times .0087265. The value of R in the above formula cannot be in the first case ten times what it is in the second.

If you remember that the angle made by a chord and tangent at any point is equal to one-half of the angle at the center subtended by the same chord, Art. 69 of Henck's Field Book gives the above formula.

I send you with this a circular, showing the present occupations of the graduates of our department of Dartmouth College, including the occupations also of our last three classes, which shows how many of them go into the engineering profession. I thought perhaps it might be of interest to you.

J. V. HAZEN,
Prof. Theoretical and Applied Mechanics.

Following is the list above referred to showing occupations: Whole number of graduates, 291; number now living, 257; civil and mechanical engineers, 62; lawyers, 30; teachers, 22; physicians, 18; merchants, 23; railroad business, 5; professors, 6; college tutors, 1; chemists, 5; clerks, 8; farmers, 7; journalists, 3; clergymen, 4; draughtsmen, 3; cashiers and treasurers, 3; professor in U. S. Navy, 1; assistant engineer U. S. Navy, 1; member of Congress, 1; judge, 1; astronomer, 1; artists, 2; lieutenant U. S. Navy, 1; machinist, 1; publisher, 1; architects, 3; real estate agents, 2; private secretary, 1; mining engineers, 5; commercial traveler, 1; bankers, 2; undertaker, 1; unknown, 32.

Present employment of the members of the last three classes: Whole number, 46; civil engineers, 21; chemists, 3; draughtsmen, 2; law students, 2; college tutor, 1; clerks, 1; private secretary, 1; teachers, 3; farmer, 1; mining engineers, 2; medical student, 1; physician, 1; bank cashier, 1; manufacturers, 2; theological student, 1; student, 1; agent for manufacturing firm, 1.

SUSPENSION BRIDGES.

EDITOR ENGINEERING NEWS:

In your issue of April 22, you have a criticism upon my paper entitled "A New Theory of the Suspension System with Stiffening Truss," re-

cently published in the Journal of the Franklin Institute, in regard to which I would like to say a few words.

You begin by asking the value of mathematical investigations based upon assumptions, when these very assumptions admit of question.

That is precisely the question suggested by my paper. I state clearly the assumptions of the ordinary theory. I point out that these assumptions are plainly incorrect, and I do my best to show how they may be dispensed with. To compare me in this connection with the theorist, who when informed of the facts, coolly remarks "so much the worse for the facts," seems to me rather unfair. In fact, I should say the boot was on the other leg. I say in effect, "look at the facts; they are not in accord with your theory. Would it not be just as well to make your theory with some reference to the facts?" You seem to me to say in effect, "deuce take your facts, *this is my theory.*"

Now, the ordinary theory is this: The curve of the cable remains parabolic; the truss distributes the partial load and prevents the change of shape.

I answer in my paper, this is known *not* to be so. The curve of the cable does not remain parabolic, nor does the truss really so distribute the load. Who is here the theorist?

I then go on to show how we may proceed *without* making this erroneous assumption. To be sure the paper is couched in mathematical terms and formulæ. I couldn't help this. I would gladly have helped it if I could. But I couldn't. Really and truly, the higher mathematics are sometimes necessary, even indispensable. But then, you know, I was unfolding a "theory" for "theoretical men," and I think they will be able to tackle it, "bewildering" as it may seem. The very thought which led to my paper, abstract as it may seem, was, what in the world is the use of swearing by a "theory" which violates practical common sense in its very fundamental assumptions? I think you will agree with me that, whatever the value of my paper, this is working in the right direction.

You then notice the fact that I find the full "H" of the cable, according to the old theory, and you wonder what gain there can be, if, after all my work, I have to fall back on that which I condemn.

I would answer simply that we are dealing with two systems, cable and truss. *So far as cable is concerned* (these are the words of my paper), "H" can be found accurately enough by the old theory. A longer and even more "bewildering" discussion than I have given would not give "H" more accurately. So, like a sensible man, I didn't enter into that question at all.

But, *so far as the truss is concerned*, "H" is *only one* of the quantities which govern the strains in that. So my two equations "with three unknown quantities" may perhaps be of some value after all.

Then you speak of "rigidity." Now here, I think, you misunderstand me. By rigidity I don't mean lack of elasticity, but *freedom from undulations*. I don't think even Roebling himself would consider liability to undulations a very great advantage; at least, as I understand it, he inserted stays, partly at least, to break up these same undulations, and then not completely successful, he places stringent orders and regulations at the entrance of the bridge, as to character of load, speed etc., which these undulations will not permit.

Now, my theory differs from the ordinary in that it *finds the strains due to these undulations*, and that is just where I think you have misunderstood my use of the term "rigidity," and failed to see the point of my paper.

As to the stays, of which you make such a strong point, I would say, if you want them, *put them in*. Any careful reader of my paper will see that this is an unessential point of the theory. Proportion your system as though there were no stays, and then, if you want to, put in as many as you choose. I only say in my paper, what seems to me sound, that if *properly* proportioned without stays, I don't think you will find stays any advantage. The theory remains the same, whether you have them or not. They only seem to me an unnecessary addition to the properly proportioned system; a disturbing element; and I can't, I confess, see how they can answer any useful purpose. I can see the force of Roebling's remarks, which you quote, but those remarks were made concerning *his* system, and do not hold at all for that proposed. That is another point which I think has escaped you. I think in any of Roebling's suspension systems, if the material of the stays were put into the trusses and the trusses properly proportioned according to true theory, there would be a gain, not of rigidity in your sense, but of freedom from undulations in mine. Roebling put in his stays, by assuming a certain constant area of cross-section for all of them whatever their angle of inclination or wherever attached, and assuming they would take, all of them, a load equal to their safe load. He assumed that the truss acted simply to stiffen, and kept the curve of the cable intact. He assumed several other points equally questionable, and when I call these assumptions to account, it certainly does seem to me that I am not the man who says "so much the worse for the facts."

Finally, you refer to the good service of some structures in our midst "which bid fair to live down all cavilling" as an argument against any "new theory." I need scarcely point out to you that the safety of a completed structure is no argument at all. Good design lies, theoretically, in making the best use of your material, and practically in getting the best result for least cost. How far my theory may lead to the latter result I know not—nor do you. It needs to be tested, not necessarily by actual construction, but by comparison of strain sheets and bill of materials. As to the first, safety is no test at all. A structure may be perfectly safe and have in it blunders innumerable of design. The application of such a test and the careless acceptance of such a careless argument would put an end to all scientific progress in engineering construction. Yours very truly,

A. J. DU BOIS.

METHOD OF REPLACING CHORD BARS.

DES MOINES, Ia., April 27, 1882.

EDITOR ENGINEERING NEWS:

Would a truss, as shown in the figure below, be self-supporting supposing the dotted members

ak and *hl* were removed and the ties *hi* and *ie* added, also counter-struts between *ci* and *dh*. I say not, while several others think differently.

ASSISTANT ENGINEER.

P. S.—The occasion for the problem came of the necessity of replacing two of the chord bars in the panel *kl*. The plan used consisted of ties from *k* to *b* and *d* while the change was made at *k*, and then from *t* to *l* and *e* while the change was made at *l*, the chord strain being taken up by long U-shaped rods around the piers on each side of the one where the change was to be made and their ends connected by turn-buckles. No difficulty was experienced in making the change. The parties making the change desired to use the other plan, because it would, if it would at all, have enabled them to make the change at both panel points at once, and without any change in the temporary trussing, etc. A. E.

ELECTRIC LIGHTS FOR HELL GATE.

A BILL FOR MAKING THE GREAT WATER-WAY AS LIGHT BY NIGHT AS BY DAY.

WASHINGTON, May 2.—The House Committee on Commerce has favorably reported a bill making an appropriation for the establishment of electric lights at Hell Gate. It is proposed to erect two skeleton iron towers from 150 to 200 ft. high, one at Hallett's Point and one at Negro Head, on Ward's Island, or at such place as may be chosen by the Light-house Board. On each tower will be 10 lights, and the cost of the carbons consumed on each tower will be 20 cents an hour. One engine of 20 horse-power will do the work. The light shown from each tower will have a 20,000 candle power, and its full force can be concentrated upon that part of the passage which is most dangerous or difficult to navigate without affecting the vision of helmsmen or sailors. The committee says that from 80,000 to 100,000 vessels pass through Hell Gate every year, or a greater tonnage than leaves this country each year for Europe. For five years the Light-house Board has asked Congress for money with which to make experiments with the electric light, and the committee say that no better place than Hell Gate could be chosen for an experiment. The report was prepared by D. H. Richardson, of the Twenty-ninth Congressional District of New York, and it continues as follows:

We can, by the means suggested, make this important and crowded water-way safe at all hours of the night. At present, sailing vessels approaching the Gate at night are compelled to anchor until morning, and in consequence of this, at daybreak, when the large sound steamers come into the harbor, the channel is filled with sailing craft and the dangers of collision accordingly increased. The electric light at Hell Gate will avoid this blockade with its risks. It will enable the Sound steamers bound eastward, to leave New York at 6 o'clock in the winter as they do in summer, thereby saving from one to two hours. When established, many vessels will take the Sound instead of the outside route. There will be a saving of time and a lessening of danger. The increasing size of the Sound steamers and the multitude of passengers carried by them, and the rapid increase in the number of vessels, especially of the larger class, render it necessary that Hell Gate be made as safe by night as by day.

Commander Dewey, Naval Secretary of the Light-house Board, supports the position taken by Mr. Richardson of the committee. In his opinion such lights would prevent the jam which occurs every morning, caused by vessels which anchor off Riker's Island and Whitestone during the night to wait for daylight before going through. Not long ago 180 sailing vessels went through the Gate in the morning at one tide.

NOTES.

INTERESTING TO WATER TAKERS.

Messrs. Newhall & Collins, shoe manufacturers, of Lynn, Mass., rented a portion of the block of John Wooldredge on Mt. Vernon street, and then asked the Public Water Board to let water in to said premises, which request was refused upon the ground, as alleged, that Mr. Wooldredge was in arrears of $80 for water supplied to that block. The shoe firm was given a hearing upon the matter, after which the Water Board voted not to let on the water. Messrs. Baldwin & Baker, attorneys for Newhall & Collins, petitioned the Supreme Court at Salem to command the Lynn Public Water Board to let on the water to their premises, the plaintiffs being willing to conform to all proper rules of said board. Counsel quoted several cases of a somewhat similar nature, and also the English case Wilkinson v. Sheffield Water Company in 1878, which closely resembled the one in question, wherein the plaintiff's prayer was granted. The Court, Judge Devens, granted the prayer of Messrs. Newhall & Collins, saying that the right to take water is a public right. One citizen cannot be made responsible for the debt of another without he assumes such debt.

GENERAL MANUFACTURING NOTES.

The Boston Commercial Bulletin says: "Only about three-fourths of the pool sale of copper is sold for consumption; the other fourth of 5,000,000 lbs. goes into the hands of dealers who, of course, must make a profit. The chances are, therefore, that copper will rule ½ or ¾ of a cent higher than present prices. This, however, is the view of the mine owners. Metal dealers are of the opinion that not so much has been sold as reported, and that the price will decline rather than rise."

There are over $1,000,000 invested in the twenty-one glucose factories, with a capacity of 48,000 bushels of corn daily. The proportion of sugar is about four to one, thus giving a daily product in this country of 1,220,000 lbs.

Cotton manufactories are springing into existence at the South with great rapidity. Since the beginning of 1881 there has been an increase of 361,600 spindles, nearly one-third of this being in Georgia and South Carolina. The increase in spindles in the several States has been as follows: Georgia, 106,600; Alabama, 34,000; Tennessee, 24,000; Mississippi, 32,000; Louisiana, 21,000; North Carolina, 48,000; South Carolina, 96,000.

Coke making is a large industry in Western Pennsylvania. The soft, bituminous coal used is in the "Pittsburgh basin," southeast of the city of that name, and is found in a vein from 8 to 11 ft. thick, at various depths up to 300 ft., and is from 2 to 12 miles wide and 40 long. There are 8,000 "ovens" in operation, and the product last year was 2,760,037 tons.

The greatest single manufacturing interest in New York, says *The American Protectionist*, is that of clothing. There are 950 clothing factories, producing nearly $80,000,000 worth of goods per year. Next in number of establishments comes the cigar industry, with 751 factories, and an annual production of $18,000,000. There are 540 printing and publishing houses, which annually issues $24,000,000 worth of literature. The furniture manufacturers turn out yearly over $10,000,000 worth of goods.

LONG BRIDGES.

Mr. K. Pfarski has made a list of the longest bridges at present existing, which are the following, their lengths being given in meters—about 3 ft. 3¾ in.: Parkersburg Bridge, 2,147; St. Charles Bridge, over the Missouri, 1,993; Ohio Bridge, near Louisville, 1,615; bridge over the East River, 1,500; Delaware Bridge, Philadelphia, 1,500; Victoria Bridge, over the St. Lawrence, 1,500; new Volga Bridge, near Syssran, 1,485; Hollands-Diep Bridge, near Moerdyk, 1,479; bridge over the Pongabuda, near Gooty (India), 1,130; Dniester Bridge, near Kiew, 1,091; Rhine Bridge, near Mainz, 1,038; Dnieper Bridge, in Pultawa (Russia), 974; Mississippi Bridge, near Quincy, 972; Missouri Bridge, near Omaha, 850; Weichsel Bridge, near Dirschau, 837; Danube Bridge, near Stadlau, 769; Po Bridge, near Mezzana Corti, 758; Tamar Bridge, near Saltash, 665; Leck Bridge, near Kuilenberg, 665; Mississippi Bridge, near Dubuque, 536; bridge over the Gorai River (India), 529; Britannia Bridge, near Bangor, 464; Saane Bridge, near Freiburg, 382; Theiss Bridge, near Szegedin, 355. The new Volga Bridge, near Syssran, is accordingly the longest in Europe.